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(54) Load sensor and pointing equipment incorporating the same

Kraftwandler und Hinweiseinrichtung mit einem solchen Kraftwandler

Capteur de force et équipement de pointage incorporant ledit capteur

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a load sensor and a pointing equipment incorporating the load sensor, built in, for example, game machines for their operating board, pointing device of personal computers, remote controllers of various electronic appliances, for inputting coordinates (two-dimensional) on a display screen by manipulating an operating rod in the front-rear and right-left directions.

BACKGROUND OF THE INVENTION

[0002] Among the conventional load sensors, a load sensor as disclosed in the Japanese Patent Laid-open No. 07-174646 is widely known. Fig.24 shows a perspective view of the conventional load sensor. An elastic board 1 is fixed at four corners to a base 3 with a fixing member 4, and an operating rod 2 made of a rigid material is provided at the center of elastic board 1. When the end of operating rod 2 is given with a force in parallel with the elastic board 1, the elastic board 1 makes a deformation. In the areas between the operating rod 2 and the fixing member 4, a pair of strain detecting elements 5 and 6 are provided respectively on lines connecting the fixing member 4 and the operating rod 2 forming right angles to each other at a same distance from the operating rod 2, totalling two pairs; the first pair of strain detecting elements 5 comprising elements 5A and 5B, while the second pair of strain detecting elements 6 comprising elements 6A and 6B. These elements 5A, 5B, 6A and 6B are strain-responsive resistor elements and have a same value of resistance.

[0003] Operation of the load sensor is described referring to Fig.25. When the operating rod 2 is given at its end with a force in the direction P1 that is parallel to the elastic board 1 and going towards element 5A, the element 5A makes, together with the elastic board 1, a concave deformation, while the element 5B a convex deformation. As a result of the deformation, the resistance value of element 5A goes down, while that of element 5B goes up. Through calculation of difference in the shift of resistance value between element 5A and element 5B, the shift of resistance value is doubled, and outputted to represent the force applied to. In the mean time, the elements 6A and 6B receive only a torsional stress of a same direction, and there is no difference in the shift of resistance value between elements 6A and 6B. Therefore, only a force in the direction of coordinate axis of the first pair of strain detecting elements 5 is detected.

[0004] When the operating rod 2 is given at its end with a force in the direction P2 that is parallel to the elastic board 1 and going towards the middle point between element 5A and element 6A, the element 5A and the element 6A make a concave deformation, while the element 5B and the element 6B a convex deformation. As a result of the deformations, the resistance value of the elements 5A and 6A goes down, while that of the elements 5B and 6B goes up. The difference in the shift of resistance value between element 5A and element 5B of the first pair of strain detecting element 5, and the difference in the shift of resistance value between element 6A and element 6B of the second pair of strain detecting element 6 are calculated respectively to compare the differences, and the strength and the direction of the force applied to are detected and outputted. In the way described above, a force applied to the operating rod 2 is split into the elements of two coordinate axes, and the strength and direction are detected.

[0005] The conventional load sensors, however, carry with them tasks for improvement with respect to the ease of operation, in the following points.

[0006] Point 1 is that a load sensor is employed only as means for moving cursor on a display screen, and an execute switch is provided separately. An operator has to move his or her fingers to the execute switch every time when to make execute action.

[0007] Point 2 is that an operating rod is protruding for a certain length in excess of an overall contour shape of an appliance. This is a limiting factor in designing an appliance slim. Also, such an operating rod is readily affected by an external force, and could easily be deformed if the force is big.

[0008] Point 3 is that an expensive ceramic plate or enamel plate is used for the elastic board, and that the operating load-output voltage level relation of a load sensor is determined only by stiffness of the elastic board. Which means that the designing freedom is limited, and it is not easy to meet the diversifying requirements of customers swiftly and economically.

[0009] The documents JP-A-08 087 375 and US-A-4 382 166 disclose other load sensors for a pointing device. The document EP-A-0 717 424 describes a rotary encoder for an audio system in a car. The encoder has a rotary shaft, a rotary plate which is rotatable around the rotational axis, a connecting member for connecting the rotary shaft and the rotary plate, which retracts in an axial direction of the rotary shaft and does not retract in a rotary direction of the rotary plate, and an output terminal for outputting a signal in accordance with rotation of the rotary plate. This rotary encoder is capable of detecting an amount of play and can prevent the generation clatter so that it may be used as a part of an audio apparatus.

SUMMARY OF THE INVENTION

[0010] The present invention offers an easy-to-use load sensor. Thus, the present invention concerns a combination of a case and a load sensor as defined in the appended claims.

[0011] An exemplary embodiment of the invented load sensor comprises an elastic board having at least

two strain detecting elements, an operating portion having a through hole positioned at the center of the elastic board, a base on which the elastic board is to be fixed at the edges, and an operating rod inserted in the through hole.

[0012] Preferably, a switch is provided under an operating rod inserted through the through hole of the elastic board. With such structure, an action for applying a force in parallel with the elastic board and an action of applying a vertical force for operating the switch may be conducted by an operator without changing the position of hand. This contributes to improve the efficiency of operation significantly.

[0013] Preferably, a spring is provided for always pushing an operating rod inserted through a through hole up, or a lock mechanism is provided for having an operating rod stop at a predetermined position within a range of up/down movement of the operating rod. With such structure, an operating rod is normally kept popped-out for the ease of manipulation, while it can be shrunk for storage when it is out of use to avoid possible deformation. Also, the overall height of a load sensor may made lower.

[0014] In a still other embodiment, an elastic insulating resin substrate overlaid together for reinforcement with an elastic metal sheet is employed for the elastic board. Under such a structure, any desired combinations of the operating load - the output voltage property may be established easily by changing the material, shape, thickness etc. of the reinforcing sheet to be coupled with a certain substrate. Furthermore, because this makes it possible to use any of insulating resin materials in combination with any of elastic metal materials readily available in the market, an inexpensive load sensor may be offered.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig.1 is a cross sectional view showing a load sensor in accordance with a first embodiment of the present invention. Fig.2 is a perspective view showing appearance of the load sensor of Fig.1. Fig.3 is a cross sectional view showing a manipulation in the horizontal direction on the load sensor of Fig.1. Fig.4 is a cross sectional view showing a manipulation in the vertical direction on the load sensor of Fig.1.

Fig.5 is a cross sectional view showing a load sensor in accordance with a second embodiment of the present invention. Fig.6 is a cross sectional view showing a manipulation in the vertical direction on the load sensor of Fig.5.

Fig.7 is a cross sectional view showing a load sensor in accordance with a third embodiment of the present invention.

Fig.8 is a cross sectional view showing a load sensor in accordance with a fourth embodiment of the present invention.

Fig.9 is a cross sectional view showing a load sensor in accordance with a fifth embodiment of the present invention. Fig.10 is a perspective view showing appearance of the load sensor of Fig.9. Fig.11 is a cross sectional view showing a manipulation in the horizontal direction on the load sensor of Fig.9. Fig.12 is a cross sectional view showing a manipulation in the vertical direction on the load sensor of Fig.9. Fig.13(a), Fig.13(b) and Fig.13(c) describe a pointing device incorporating the load sensor of Fig.9; the respective drawings show a perspective view, a cross sectional view with lid open and a cross sectional view when the lid is closed.

Fig.14 is a cross sectional view showing a load sensor in accordance with a sixth embodiment of the present invention. Fig.15 is a cross sectional view showing a manipulation in the vertical direction on the load sensor of Fig.14.

Fig.16 is a cross sectional view showing a load sensor in accordance with a seventh embodiment of the present invention. Fig.17 is a cross sectional view at line G - G of Fig.16. Fig.18 is a cross sectional view showing a manipulation in the vertical direction on the load sensor of Fig.16.

Fig.19 is a cross sectional view showing a load sensor in accordance with an eighth embodiment of the present invention. Fig.20 is a cross sectional view at line H - H of Fig.19. Fig.21 is a cross sectional view showing a manipulation in the vertical direction on the load sensor of Fig.19.

Fig.22 is a cross sectional view showing a load sensor in accordance with a ninth embodiment of the present invention. Fig.23 is a cross sectional view showing a manipulation in the vertical direction on the load sensor of Fig.22.

Fig.24 a perspective view showing appearance of a conventional load sensor. Fig.25 is a cross sectional view showing the conventional load sensor of Fig.24 at work.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Preferred embodiments of the present invention are described hereunder with reference to drawings. Those constituent parts having the same function as those in the conventional are represented by using the same symbols, and detailed descriptions of which are omitted here.

(Embodiment 1)

[0017] In a load sensor in accordance with a first exemplary embodiment of the present invention as shown in Fig.1 and Fig.2, an elastic board 11 is fixed at four

corners on a rigid base 14 by fixing members 4. Provided at the center of elastic board 11 is an operating part 13 which contains a through hole 13A. Fitting part 12B of an operating rod 12 is held by the through hole 13A to be movable ups and downs. Beneath the operating rod 12, an elastic trip-back type push-button switch 15 is fixed on the base 14 at a holding part 14A. On the elastic board 11, a first pair of strain detecting elements 5 (5A, 5B) and a second pair of strain detecting elements 6 (6A, 6B), both composed of strain-responsive resistor elements having a same resistance value, are provided respectively on lines connecting the fixing member 4 and the operating part 13 forming right angles to each other at a same distance from the operating part 13.

[0018] Operation of the load sensor is described referring to Fig.3 and Fig.4.

[0019] As shown in Fig.3, when the operating rod 12 is given at the top end 12A with a force in the direction P1 that is parallel with elastic board 11 and going towards element 5A causing a tilted operating rod 12, the force is conveyed to elastic board 11 via operating part 13, because the fitting part 12B is fitted in the through hole 13A with a very small gap. As a result, one element 5A of the first pair of strain detecting element 5 is deformed to make a concave shape, while the other element 5B a convex shape. The deformation lowers the resistance value of element 5A, and raises the resistance value of element 5B. Through calculation of difference in the shift of resistance value between element 5A and element 5B, the shift of resistance value is doubled and outputted to represent the force applied to. In the mean time, the second pair of strain detection elements 6 (see Fig.2) receive only torsional stress of a same direction, and no difference arises in the shift of resistance value. Therefore, only a force in the direction of coordinate axis of the first pair of strain detecting elements 5 is detected.

[0020] When the top end 12A is given with a force in the direction P2 that is parallel with elastic board 1 and going towards the middle point between element 5A and element 6A, the element 5A and element 6A make a concave deformation, while the element 5B and element 6B a convex deformation. As a result of the deformations, the resistance value of the elements 5A and 6A goes down, while that of elements 5B and 6B goes up. The difference in the shift of resistance value between element 5A and element 5B, and difference in the shift of resistance value between element 6A and element 6B are calculated respectively to compare the differences; and the sstrength and the direction of the force applied to are detected and outputted.

[0021] Thus the direction of move of top end 12A is detected in the form of ratio in the difference of resistance value shift between the first and the second pairs of strain detecting elements 5, 6; while the quantity of move of top end 12A is detected in terms of the large or the small of difference of resistance shift between the first and the second pairs of strain detecting elements 5, 6. When the operating rod 12 is tilted during horizontal manipulation, the bottom end 12C may push the button 15A of push-button switch 15 for a small quantity. However, an elastic restorative force provided for push button switch 15 prevents the switch from going into action.

[0022] As shown in Fig.4, when the top end 12A is given with a pressing force in the direction P3 that is perpendicular to elastic board 11, the operating rod 12 which is fitted to be movable ups and downs at the fitting part 12B with the through hole 13A sinks down. The button 15A of push button switch 15 disposed on base 14 is pressed by the bottom end 12C of operating rod 12, and the push button switch 15 is put into action. As soon as the downward pressing force P3 exerted on top end 12A is removed, the button 15A is returned to initial position by the elastic restorative force of push-button switch 15, bottom end 12C is pushed up and the operating rod 12 too is returned to initial position.

[0023] As described above, in a load sensor in accordance with the Embodiment 1, the horizontal manipulation at the top end 12A of operating rod 12 may be detected through calculation of the difference in the shift of resistance value respectively in the first and the second pairs of strain detecting elements 5, 6, and the push-button switch 15 may also be operated by pushing the top end 12A down. In this way, both the transfer of coordinates on a display screen and the inputting may be conducted with the operating rod 12 only. A load sensor may thus be presented with which the operational convenience is significantly improved. Just for information, the resistance value of strain detecting elements 5, 6 do not shift because no force is applied on the elastic board 11 during the vertical manipulation.

[0024] It is preferred to use a click action switch for the push-button switch 15. This further enhances the operational advantage because the switching action is felt through the finger.

[0025] Although the strain detecting elements 5, 6 are disposed on the upper surface of elastic board 11 in the above descriptions, these elements may of course be disposed on the reverse surface of elastic board 11. Although a strain-responsive resistor element is formed on the elastic board 11 by a printing process for the elements 5A, 5B, 6A and 6B, a strain gauge may be mounted on the elastic board 11 for the same purpose. In the latter case, it is easy to comply with various elastic boards of diversified shapes and sizes. On the other hand, the strain-responsive resistor elements are advantageous in that the dislocation of position and the dispersion of resistance value are small with these elements, also the volume production is easier with these elements. Therefore, a load sensor of high detecting precision may be presented at an inexpensive price level.

(Embodiment 2)

[0026] The point of difference with a load sensor of an

exemplary embodiment 2 of the present invention, shown in Fig.5, as compared with that of embodiment 1, is in the shapes of fitting part 16B of operating rod 16 and through hole 17A of operating part 17. Namely, the fitting part 16B has a tapered shape, going slimmer towards the top and thicker towards the bottom, and the through hole 17A is shaped accordingly.

[0027] Operation of the load sensor is described with reference to Fig.6. When a downward force is given on top end 16A of operating rod 16 in the direction P3 that is perpendicular to elastic board 11, the operating rod 16 is pushed down to press a button 15A with its bottom end 16C. A push-button switch 15 is thus put into action. When, the clearance between the fitting part 16B and the through hole 17A goes larger, making the operating part 17 and the elastic board 11 less affected by the motion of operating rod 16. Therefore, even if a horizontal force is given by mistake to the top end 16A during the operation on push-button switch 15, the force is least conveyed to the operating part 17 and a possibility for the strain detecting elements 5, 6 making erroneous action is reduced. While in the normal state, the operating rod 16 is kept in the initial position by the elastic restorative force'of push-button switch 15, and the clearance between fitting part 16B and through hole 17A is small. Therefore, the play of operating rod is small.

[0028] In the above description, both of the fitting part 16B and the through hole 17A have a tapered shape. It is also possible that at least one of the fitting part 16B and the through hole 17A has a stepped form in which the diameter is smaller in the upper part and larger in the lower part.

(Embodiment 3)

[0029] The point of difference with a load sensor of exemplary embodiment 3 of the present invention, shown in Fig.7, as compared with that of embodiment 1, is in the structure of push-button switch. Namely, a push button switch 21 is composed of a base 18 of insulating material having a circular hollow 18A, at the bottom circumference of the circular hollow 18A an electro-conductive outer fixed-contact-point 18B is provided, and an electro-conductive central fixed-contact-point 18C at the center. On the outer fixed-contact-point 18B, a domed movable-contact-point 19 made of elastic thin metal sheet is provided with its circumferential edge 19A down, and an insulating button 20 on the movable-contact-point 19. When operating rod 12 is pressed and the button 20 is pushed down, the movable-contact-point 19 makes contact with the central fixed-contact-point 18C on the base 18, and an electrical signal is transmitted through electric signal output terminals 18D, 18E to a circuit of an electronic appliance.

[0030] By using the base 18 also as switch case of the push-button switch 21, the total number of constituent components, including the push-button switch, may be reduced. Thus a compact load sensor of lower height may be presented. The material cost of such sensors may be economical, and manufacturing of which may be easier too.

[0031] In the above description, the button 20 and the operating rod 12 are structured independent. It is also possible to form a button-less switch by structuring the button and the operating rod 12 as a one-piece member with an insulating material. By so doing, the total number of constituent components of a load sensor may be reduced.

(Embodiment 4)

[0032] The point of difference with a load sensor of exemplary embodiment 4 of the present invention, shown in Fig.8, as compared with that of embodiment 1, is that a buffer is disposed between the operating rod 22 and the button 15A in the present embodiment 4. A buffer 23 made of elastic material is placed between the bottom end 22C of operating rod 22 and the button 15A of the switch 15. By so doing, push-button switch 15 may be protected against deformation or breakage even when an unusually large downward shock is given on the top end 22A of operating rod 22.

[0033] In the above description, the button 15A and the buffer 23 are structured independent. It is also possible to form the button 15A with an insulating elastic material into a single member containing the function of buffer 23. By so doing, the same effects may be obtained with less number of constituent components.

(Embodiment 5)

[0034] In a load sensor in accordance with a fifth exemplary embodiment of the present invention as shown in Fig.9 and Fig.10, an elastic board 31 is fixed at four corners on a rigid base 34 with fixing members 4. Provided at the center of elastic board 31 is an operating part 33 which contains a through hole 33A. Fitting part 32B of an operating rod 32 is held by the through hole 33A to be movable ups and downs. Beneath the operating rod 32, a conical coil spring 35 made of elastic metal wire is provided on base 34 to push up a larger-diameter bottom end 32C of the operating rod 32 to upper stopper 34A of the base 34. On the elastic board 31, a first pair of strain detecting elements 5 (5A, 5B) and a second pair of strain detecting elements 6 (6A, 6B), both comprised of strain-responsive resistor elements having a same resistance value, are provided respectively on lines connecting the fixing members 4 and the operating part 33 forming right angles to each other at a same distance from the operating part 33.

[0035] Operation of the load sensor is described referring to Fig.11 and Fig.12. When the operating rod 32 is given at the top end 32A with a force in the direction P1 that is parallel with elastic board 31 and going towards element 5A causing tilted operating rod 32, the force is conveyed to elastic board 31 via operating part

33 because the fitting part 32B is fitted in the through hole 33A with a very small gap. As a result, one element 5A of the first pair of strain detecting element 5 is deformed to make a concave shape, while the other element 5B a convex shape. The deformation lowers the resistance value of element 5A and raises the resistance value of element 5B. Through calculation of difference in the shift of resistance value between element 5A and element 5B, the shift of resistance value is doubled and outputted to represent the force applied to. In the mean time, the second pair of strain detection elements 6 (see Fig.10) receive only torsional stress of a same direction, and no difference arises in the shift of resistance value. Therefore, only a force in the direction of coordinate axis of the first pair of strain detecting elements 5 is detected.

[0036] When the top end 32A is given with a force in the direction P2 that is parallel with elastic board 31 and going towards the middle point between element 5A and element 6A, the element 5A and the element 6A make a concave deformation, while the element 5B and the element 6B a convex deformation. As a result of these deformations, the resistance value of the elements 5A and 6A goes down, while that of elements 5B and 6B goes up. The difference in the shift of resistance value between element 5A and element 5B, and difference in the shift of resistance value between element 6A and element 6B are calculated respectively to compare the differences; and the size and the direction of the force applied to are detected and outputted.

[0037] Thus the direction of move of top end 32A is detected in the form of ratio in the difference of resistance value shift between the first and the second pairs of strain detecting elements 5, 6; while the quantity of move of top end 32A is detected in terms of the large or the small of difference of resistance shift between the first and the second pairs of strain detecting elements 5, 6. During the horizontal manipulation, or the operating rod 32 is tilted as a result, the bottom end 32C is pushed up by spring 35 to the upper stopper 34A; therefore, the operating rod 32 is kept protruded to the operating position.

[0038] If the top end 32A is given with a pressing force in the direction P3 that is perpendicular to elastic board 31, the operating rod 32 which is fitted to be movable ups and downs at the fitting part 32B with the through hole 33A sinks down, as shown in Fig.12. As soon as the downward pressing force P3 exerted on top end 32A is removed, the bottom end 32C is pushed back by elastic restorative force of spring 35 to the upper stopper 34A, or to the operating position.

[0039] Now in the following, description is made on a pointing equipment incorporating the load sensor, referring to Fig.13(a) Fig.13(c).

[0040] A pointing equipment 38 incorporating the load sensor 39 is comprised of a case 36 having a round opening 36A to allow the operating rod 32 of load sensor 39 fixed on the operation panel 36D to pop out, and a lid 37 affixed to the case 36 with a hinge 36C. In order to enable the lid to be closed when out of service, a lock mechanism is provided, which is comprised of a claw 37A provided at the lid 37 and a square hole 36B provided at the case 36.

[0041] When the pointing equipment 38 is on service and the lid 37 is in open state, the operating rod 32 is pushed up by the elastic force of spring 35 disposed beneath the operating rod 32 and the top end 32A is protruding above the operation panel 36D for easy manipulation, as shown in Fig.13(b). When it is out of service and the lid 37 is in closed state, the lid 37 touches on the operating rod 32 at the top end 32A to push down the operating rod 32, as shown in Fig.13(c). Thus the lid 37 may be closed without any problem.

[0042] As described above, the operating rod 32 pops out for easy manipulation during use, and sinks down when out of use; therefore, the overall height may be reduced and a deformation trouble with the operating rod may also be avoidable. When a conical coil spring, among others, is used for the spring 35 the height at compression may become very small, which contributes to make an appliance thinner. In place of the conical coil spring 35, a cylindrical coil spring, a U-shape spring, leaf spring, etc. may of course be used for the same purpose.

[0043] Although the strain detecting elements 5, 6 are disposed on the upper surface of elastic board 31 in the present embodiment 5, these elements may of course be disposed on the opposite surface of elastic board 31. Although a strain-responsive resistor element has been formed on the elastic board 31 by a printing process for the elements 5A, 5B, 6A and 6B, a strain gauge may be mounted instead on the elastic board 31 for the same purpose. In the latter case, it is easy to comply with various elastic boards of diversified shapes and sizes. On the other hand, the strain-responsive resistor elements are advantageous in that the dislocation of position and the dispersion of resistance value are small with these elements, and volume production is easy too with these elements. Therefore, a load sensor of high detecting precision may be presented at an inexpensive price level.

[0044] Although in the above pointing device the lid 37 is connected to the case 36 at the hinge 36C, it may come in a sliding lid or a detachable lid.

(Embodiment 6)

[0045] The point of difference with a load sensor of exemplary embodiment 6 of the present invention, shown in Fig.14, as compared with that of embodiment 5, is in the shapes of fitting part 40B of operating rod 40 and through hole 41A of operating part 41. Namely, the fitting part 40B is comprised of a small-diameter part 40D in the upper part, a large-diameter part 40E in the lower part and a tapered part 40F in between the two parts. The through hole 41A of operating part 41 is also

comprised of a small-diameter part 41B in the upper part, a large-diameter part 41C in the lower part and a tapered part 41D in between the two parts.

[0046] Operation of the load sensor is described with reference to Fig.15. When a downward force is given on a top end 40A of operating rod 40 in the direction P3 that is perpendicular to elastic board 31, the operating rod 40 is pushed down and sinks lower. As soon as the downward force is removed, the bottom part 40C is pushed back by elastic restorative force of spring 35 to touch upper stopper 34A. When the operating rod 40 is in pressed-down state, the clearance between the fitting part 40B and the through hole 41A goes larger, making the operating part 41 and the elastic board 31 to be less affected by the motion of operating rod 40.

[0047] In the present exemplary embodiment 6, even if the operating rod 40 is pressed down in somewhat oblique direction, not exactly vertical, the operating rod 40 can easily be accepted down because the clearance between fitting part 40B and through hole 41A goes larger. While in the normal working state, the operating rod 40 is kept in the initial protruding position by the elastic restorative force of spring 35 and the clearance between fitting part 40B and through hole 41A is small. Therefore, the play of operating rod is small, making the load sensor easy to manipulate in the horizontal direction. The operational details in the horizontal direction remain the same as in the embodiment 5, and description of which is skipped here.

[0048] Besides the fitting structure between operating rod 40 and operating part 41 as described above, it may be constituted with only the tapered part 40F and the tapered part 41D, or by shaping at least either one of the fitting part 40B or the through hole 41A into a stepped form in which the diameter is smaller in the upper part and larger in the lower part for the same effect.

(Embodiment 7)

[0049] The point of difference with a load sensor of exemplary embodiment 7 of the present invention, shown in Fig.16 and Fig.17, as compared with that of embodiment 5, is that there is a lock mechanism in the present embodiment which can hold an operating rod at a predetermined position within the range of up/down movement. Namely, the fitting part 42B of operating rod 42 is pinched at the fitting part 42B by a pair of parallel springs 44 comprised of elastic metal wires held by a pair of spring holding sections 43C on a base 43. Provided around the bottom end of fitting part 42B is a groove 42D, or a smaller diameter region. When the operating rod 42 is protruding, or in the working state, the parallel springs 44 are fitting with the groove 42D.

[0050] Operation of the load sensor is described in the following. Although the particulars in manipulating the operating rod 42 in horizontal direction remain the same as in embodiment 5, the operating rod 42 of the present embodiment can be kept at the protruding state, or the working state, in a stable manner even when it is tilted, because the parallel springs 44 are fitted with the groove 42D.

[0051] As to manipulation in the vertical direction, when the top end 42A is given with enough vertical force in the direction P3 that is perpendicular to elastic board 31 (a force stronger than the force engaging groove 42D with parallel springs 44), the engagement between groove 42D and parallel springs 44 is released, and the operating rod 42 is pushed down to touch the bottom stopper 43B of base 43 at the bottom end 43B, as shown in Fig.18. When, the operating rod 42 is not shaky because it is held firmly between the parallel springs 44 at the fitting part 42B. When the top end 42A is pulled up the operating rod 42 goes up until touching to upper stopper 43A and the parallel springs 44 engage with the groove 42D. Then the operating rod 42 is ready for work.

[0052] Thus with the structure of embodiment 7, where the operating rod 42 is held between parallel springs 44, the operating rod 42 may not only be stopped and held at any desired height but it may be stopped without fail at the most protruding position and held firm by the engagement of parallel springs 44 with groove 42D.

[0053] Although in the above description the groove 42D is provided for only one place on the operating rod 42, it may be provided in pluralities for holding the operating rod 42 at any predetermined heights. The parallel springs 44 may be engaged with a step, instead of the groove 42D. Also, the parallel springs 44 may be formed with a single elastic metal wire shaped into the form of letter U, letter V, etc.

(Embodiment 8)

[0054] The point of difference with a load sensor of exemplary embodiment 8 of the present invention, shown in Fig.19 and Fig.20, as compared with that of embodiment 7, is in the use of repulsion spring 47 provided between operating rod 45 and base 46 for the lock mechanism. Namely, a pair of spring holding sections 46C facing each other are provided as part of the base 46 at the middle point of up and down movement range of the bottom end 45C of operating rod 45, and a spring holding section 45D comprised of a pair of holes is provided at the bottom end 45C of fitting part 45B. A pair of U-shape repulsion springs 47 made of an elastic metal wire are provided revolvable between the spring holding sections 46C, 45D.

[0055] Operation of the load sensor is described in the following. The basics in horizontal manipulation of operating rod 45 remain the same as those described in embodiment 5. What is different is that when the operating rod 45 is tilted the bottom end 45C is pushed up by repulsion spring 47 to keep touching with the upper stopper 46A; as a result, the operating rod 45 can stably maintain the working state, or protruding state.

[0056] As shown in Fig. 21, for vertical manipulation

of the operating rod 45, a downward force stronger than the push-up force of repulsion spring 47 is to be applied on the top end 45A in the direction P3 that is perpendicular to elastic board 31. After the spring holding section 45D of operating rod 45 passes through the level of spring holding section 46C of base 46, the force of repulsion spring 47 works for lowering the operating rod 45, bringing the bottom end 45C to touch the bottom stopper 46B of base 46. In the reverse way, when the top end 45A is pulled up the operating rod 45 goes up, as soon as the spring holding section 45D passes through the level of spring holding section 46C of base 46 the operating rod 45 is pushed up by the force of repulsion spring 47 until the bottom end 45C touches the upper stopper 46A. The operating rod 45 is thus set to be ready for work.

[0057] With the load sensor of present embodiment 8, the operating rod 45 may be held firm at the most protruded position or at the most pushed-in position by the action of upward force or downward force of the repulsion spring 47.

(Embodiment 9)

[0058] The point of difference with a load sensor of exemplary embodiment 9 of the present invention, shown in Fig.22 and Fig.23, as compared with that of embodiment 7, is that the present embodiment comprises a lock mechanism that locks and releases a heart-shaped hollow 50B of lock body 50 with a pin 53A of cam 53. Namely, a lock body 50 is housed within a box-shape cover 49A formed as a part of base 49, and a coil spring 51 for pushing the lock body 50 upward is provided between the lock body 50 and the bottom wall of box-shape cover 49A. A recess 50A provided at an end of lock body 50 is engaged with a groove 48C provided at the bottom end of fitting part 48B of operating rod 48 having a top end 48A. On a lid 52 of the box-shape cover 49A is a cam 53 having a round pin 53A at an end, which is disposed revolvable and provided with a leaf spring 54 for pressing the pin 53A towards inside. The hollow 50B and the pin 53A are engaged or released along with the up and down motion of lock body 50 caused as a result of up and down movement of operating rod 48; Fig.22 shows released state and Fig.23 engaged state.

[0059] As described above, repetition of push-in action on operating rod 48 brings it, and fixes, to a protruding state (lock being released), or working state, and a withheld state (push-locked), or off-duty state, in turn.

[0060] The invention may be embodied in other specific forms without departing from the essential characteristics thereof. For example, in the above embodiments only the exemplary cases in which four strain detecting elements are employed have been described, however the number does not always to be four, it may be at least two. Accordingly, it is intended that the appended claims be interpreted as covering all alterations and modifications as fall within the scope of the invention.

Claims

1. A combination of a case (36) and a load sensor (39), said load sensor comprising a

   - an elastic board having at least two strain detecting elements,
   - a base for fixing said elastic board at its edges,
   - an operating rod (32)
   - an operating part having a through hole positioned at the centre of said elastic board, said operating rod being inserted in said through hole such that said operating rod (32) is movable along its longitudinal axis independently to said elastic board, wherein
     when said operating rod is provided with a force in a direction that is parallel to said elastic board, said force is conveyed to said elastic board via said operating part,

   said case (36) comprising

   - an operation panel (36D) provided with an opening (36A) in which the operating rod is located whereby said operating rod is moveable along its longitudinal axis independently to said operation panel (36D) so as to allow said operating rod (32) to protrude above the operation panel (36D) for easy manipulation and to sink down for storage when out of use.

2. The device of claim 1, further comprising a switch provided under said operating rod, said switch operated by said operating rod.

3. The device of claim 2, wherein said switch is a switch that works with a click action.

4. The device of claim 2, wherein the surfaces of outer wall of said operating rod and inner wall of said through hole are tapered.

5. The device of claim 2, wherein at least one of outer wall of said operating rod and inner wall of said through hole is provided with a stepped form.

6. The device of claim 2, wherein said switch comprises a pair of fixed contact-points formed on said base of insulating material and an elastic movable contact-point disposed above the fixed contact-points.

7. The device of claim 2, further comprising a buffer made of an elastic high polymer material provided between said switch and said operating rod.

8. The device of claim 2, wherein said at least two strain detecting elements comprise strain gauges attached on said elastic board.

9. The device of claim 2, wherein said at least two strain detecting elements comprise strain-responsive resistor elements formed by a printing process on said elastic board.

10. The device of claim 1, further comprising a spring provided between the bottom end of said operating rod and said base for pushing said operating rod up.

11. The device of claim 10, wherein said spring comprises a conical coil spring.

12. The device of claim 10, wherein the surfaces of outer wall of said operating rod and inner wall of said through hole are tapered.

13. The device of claim 10, wherein at least one of outer wall of said operating rod and inner wall of said through hole is provided with a stepped form.

14. The device of claim 1, further comprising a lock mechanism provided as a part of said base for stopping said operating rod at a predetermined position within a range of up and down motion.

15. The device of claim 14, wherein said lock mechanism comprises a parallel spring held on said base and one of a groove and a step provided at the bottom end of said operating rod for a clamping with said spring.

16. The device of claim 14, wherein said lock mechanism comprises a first holding part provided close to the bottom end of said operating rod, a second holding part provided as a part of said base at the middle level of up and down movement range of said first holding part, and a repulsion spring coupling said first holding part and said second holding part.

17. The device of claim 14, wherein said lock mechanism comprises a lock body having a hollow and being linked with the up and down motion of said operating rod, and a cam having a pin for engagement with said hollow and being attached on said base.

18. The device of claim 10 or 14, wherein said at least two strain detecting elements comprise strain gauges attached on said elastic board.

19. The device of claim 10 or 14, wherein said at least two strain detecting elements comprise strain-responsive resistor elements formed by a printing process on said elastic board.

20. A pointing equipment comprising a device of claim 10 or 14 said case being provided with a lid, wherein said load sensor is incorporated in said case so that said operating rod is pressed down by said lid during off-service, and is held protruded during on-duty.

Patentansprüche

1. Kombination aus einem Gehäuse (36) und einem Belastungssensor (39), wobei der Belastungssensor

   eine elastische Platte mit mindestens zwei Dehnungsmessfühlern,

   eine Grundplatte zum Befestigen der elastischen Platte an ihren Kanten,

   einen Bedienstab (32),

   ein Bedienteil mit einer in der Mitte der elastischen Platte angeordneten Durchgangsbohrung, wobei der Bedienstab (32) so in die Durchgangsbohrung eingesteckt ist, dass er entlang seiner Längsachse unabhängig zu der elastischen Platte bewegt werden kann, wobei beim Aufbringen einer Kraft auf den Bedienstab parallel zu der elastischen Platte die Kraft über das Bedienteil auf die elastische Platte übertragen wird, aufweist,

   und das Gehäuse (36)

   ein Bedienungsfeld (36D), das mit einer Öffnung (36A) versehen ist, in der sich der Bedienstab (32) befindet, sodass der Bedienstab (32) entlang seiner Längsachse unabhängig zu dem Bedienungsfeld (36D) bewegt werden kann, zur einfachen Manipulation aus dem Bedienungsfeld (36D) herausragen kann und zur Aufbewahrung bei Nichtgebrauch versenkt werden kann,

   aufweist.

2. Vorrichtung nach Anspruch 1, die außerdem einen Schalter, der unter dem Bedienstab vorgesehen ist, aufweist, wobei der Schalter von dem Bedienstab betätigt wird.

3. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der Schalter klickt.

4. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** die Oberflächen der Außenwand des Bedienstabs und der Innenwand der Durchgangsbohrung konisch zulaufen.

5. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** entweder die Außenwand des Bedienstabs oder die Innenwand der Durchgangsbohrung oder beide stufenförmig ist/sind.

6. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der Schalter ein Paar Festkontakte, die an der aus Isoliermaterial bestehenden Grundplatte ausgebildet sind, und einen über den Festkontakten angeordneten elastischen beweglichen Kontakt aufweist.

7. Vorrichtung nach Anspruch 2, die außerdem einen aus einem elastischen Hochpolymer bestehenden Puffer, der zwischen dem Schalter und dem Bedienstab vorgesehen ist, aufweist.

8. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** mindestens zwei Dehnungsmessfühler Dehnungsmessstreifen bilden, die an der elastischen Platte befestigt sind.

9. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** die mindestens zwei Dehnungsmessfühler dehnungsempfindliche Widerstandselemente aufweisen, die mit einem Druckverfahren auf der elastischen Platte aufgebracht sind.

10. Vorrichtung nach Anspruch 1, die außerdem eine zwischen dem unteren Ende des Bedienstabs und der Grundplatte vorgesehene Feder aufweist, um den Bedienstab nach oben zu stoßen.

11. Vorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** die Feder eine Kegelstumpffeder ist.

12. Vorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** die Oberflächen der Außenwand des Bedienstabs und der Innenwand der Durchgangsbohrung konisch zulaufen.

13. Vorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** entweder die Außenwand des Bedienstabs oder die Innenwand der Durchgangsbohrung oder beide stufenförmig ist/sind.

14. Vorrichtung nach Anspruch 1, die außerdem einen als Teil der Grundplatte vorgesehenen Sperrmechanismus aufweist, um den Bedienstab an einer vorgegebenen Position in einem Auf- und Abbewegungsbereich anzuhalten.

15. Vorrichtung nach Anspruch 14, **dadurch gekennzeichnet, dass** der Sperrmechanismus eine an der Grundplatte festgehaltene Parallelfeder und eine Nut und einen Absatz, die am unteren Ende des Bedienstabs zum Festklemmen mit der Feder vorgesehen sind, aufweist.

16. Vorrichtung nach Anspruch 14, **dadurch gekennzeichnet, dass** der Sperrmechanismus einen nahe am unteren Ende des Bedienstabs vorgesehenen ersten Halter, einen als Teil der Grundplatte in der Mitte des Auf- und Abbewegungsbereichs des ersten Halters vorgesehenen zweiten Halter und eine den ersten und den zweiten Halter verbindende Rückstoßfeder aufweist.

17. Vorrichtung nach Anspruch 14, **dadurch gekennzeichnet, dass** der Sperrmechanismus einen Sperrkörper, der eine Vertiefung hat und an die Auf- und Abbewegung des Bedienstabs gekoppelt ist, und einen Nocken, der einen Stift zum Einrasten in der Vertiefung hat und an der Grundplatte befestigt ist, aufweist.

18. Vorrichtung nach Anspruch 10 oder 14, **dadurch gekennzeichnet, dass** mindestens zwei Dehnungsmessfühler Dehnungsmessstreifen bilden, die an der elastischen Platte befestigt sind.

19. Vorrichtung nach Anspruch 10 oder 14, **dadurch gekennzeichnet, dass** die mindestens zwei Dehnungsmessfühler dehnungsempfindliche Widerstandselemente aufweisen, die mit einem Druckverfahren auf der elastischen Platte aufgebracht sind.

20. Zeigevorrichtung mit einer Vorrichtung nach Anspruch 10 oder 14, wobei die Vorrichtung mit einem Deckel versehen ist, **dadurch gekennzeichnet, dass** der Belastungssensor so in das Gehäuse eingebaut ist, dass der Bedienstab bei Nichtgebrauch mit dem Deckel heruntergedrückt wird und bei Gebrauch herausragt.

Revendications

1. Combinaison d'un boîtier (36) et d'un capteur de charge (39), ledit capteur de charge comprenant.

   - une carte élastique comportant au moins deux éléments de détection de contrainte,
   - une base destinée à fixer ladite carte élastique au niveau de ses bords,
   - une tige d'actionnement (32)
   - une partie d'actionnement comportant un trou traversant positionné au centre de ladite carte élastique, ladite tige d'actionnement étant insérée dans ledit trou traversant de sorte que ladite tige d'actionnement (32) soit mobile le long de son axe longitudinal indépendamment de ladite carte élastique, où
     lorsque ladite tige d'actionnement reçoit une force dans une direction qui est parallèle à ladite carte élastique, ladite force est acheminée vers ladite carte élastique par l'intermédiaire de ladite partie d'actionnement,

ledit boîtier (36) comprenant

- un panneau de commande (36D) muni d'une ouverture (36A) dans laquelle la tige d'actionnement est positionnée d'où il résulte que ladite tige d'actionnement est mobile le long de son axe longitudinal indépendamment dudit panneau de commande (36D) de façon à permettre que ladite tige d'actionnement (32) fasse saillie au-dessus du panneau de commande (36D) en vue d'une manipulation aisée et s'enfonce en vue d'un rangement lors d'une non-utilisation.

2. Dispositif selon la revendication 1, comprenant en outre un commutateur disposé sous ladite tige d'actionnement, ledit commutateur étant mis en oeuvre par ladite tige d'actionnement.

3. Dispositif selon la revendication 2, dans lequel ledit commutateur est un commutateur qui fonctionne avec une action de clic.

4. Dispositif selon la revendication 2, dans lequel les surfaces de la paroi extérieure de ladite tige d'actionnement et de la paroi intérieure dudit trou traversant sont effilées.

5. Dispositif selon la revendication 2, dans lequel au moins l'une de la paroi extérieure de ladite tige d'actionnement et de la paroi intérieure dudit trou traversant est réalisée avec une forme étagée.

6. Dispositif selon la revendication 2, dans lequel ledit commutateur comprend une paire de points de contact fixes formés sur ladite base de matériau isolant et un point de contact mobile élastique disposé audessus des points de contact fixes.

7. Dispositif selon la revendication 2, comprenant en outre un tampon fait d'un matériau de haut polymère élastique disposé entre ledit commutateur et ladite tige d'actionnement.

8. Dispositif selon la revendication 2, dans lequel lesdits au moins deux éléments de détection de contrainte comprennent des extensomètres fixés sur ladite carte élastique.

9. Dispositif selon la revendication 2, dans lequel lesdits au moins deux éléments de détection de contrainte comprennent des éléments de résistance sensibles à la contrainte formés par un procédé d'impression sur ladite carte élastique.

10. Dispositif selon la revendication 1, comprenant en outre un ressort disposé entre l'extrémité inférieure de ladite tige d'actionnement et ladite base en vue de pousser ladite tige d'actionnement vers le haut.

11. Dispositif selon la revendication 10, dans lequel ledit ressort comprend un ressort hélicoïdal conique.

12. Dispositif selon la revendication 10, dans lequel les surfaces de la paroi extérieure de ladite tige d'actionnement et de la paroi intérieure dudit trou traversant sont effilées.

13. Dispositif selon la revendication 10, dans lequel au moins l'une de la paroi extérieure de la tige d'actionnement et de la paroi intérieure dudit trou traversant est réalisée avec une forme étagée.

14. Dispositif selon la revendication 1, comprenant en outre un mécanisme de blocage prévu en tant que partie de ladite base destiné à arrêter ladite tige d'actionnement à une position prédéterminée à l'intérieur d'une plage de déplacement vers le haut et vers le bas.

15. Dispositif selon la revendication 14, dans lequel ledit mécanisme de blocage comprend un ressort parallèle maintenu sur ladite base et l'une d'une rainure et d'une marche prévue à l'extrémité inférieure de ladite tige d'actionnement en vue d'un serrage avec ledit ressort.

16. Dispositif selon la revendication 14, dans lequel ledit mécanisme de blocage comprend une première partie de maintien disposée à proximité de l'extrémité inférieure de ladite tige d'actionnement, une seconde partie de maintien prévue en tant que partie de ladite base au niveau intermédiaire de la plage de déplacement vers le haut et vers le bas de ladite première partie de maintien, et un ressort de répulsion couplant ladite première partie de maintien et ladite seconde partie de maintien.

17. Dispositif selon la revendication 14, dans lequel ledit mécanisme de blocage comprend un corps de blocage comportant un creux et qui est lié au déplacement vers le haut et vers le bas de ladite tige d'actionnement, et une came comportant une broche en vue d'une mise en prise avec ledit creux et qui est fixée sur ladite base.

18. Dispositif selon la revendication 10 ou 14, dans lequel lesdits au moins deux éléments de détection de contrainte comprennent des extensomètres fixés sur ladite carte élastique.

19. Dispositif selon la revendication 10 ou 14, dans lequel lesdits au moins deux éléments de détection de contrainte comprennent des éléments de résistance sensibles à la contrainte formés par un procédé d'impression sur ladite carte élastique.

20. Equipement de pointage comprenant un dispositif

selon la revendication 10 ou 14, ledit boîtier étant muni d'un couvercle, où ledit capteur de charge est incorporé dans ledit boîtier de sorte que ladite tige d'actionnement est pressée vers le bas par ledit couvercle durant une mise hors service, et est maintenue en saillie durant une mise sous tension.

Fig. 1

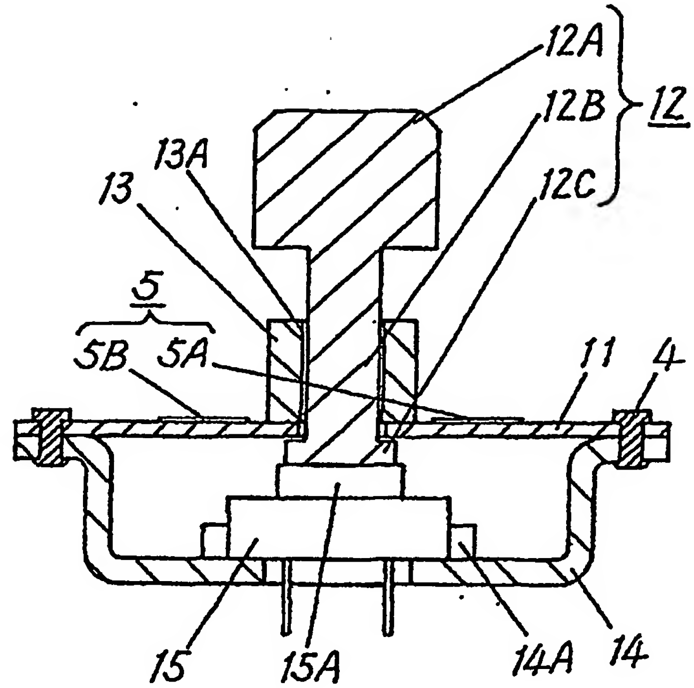

Fig. 2

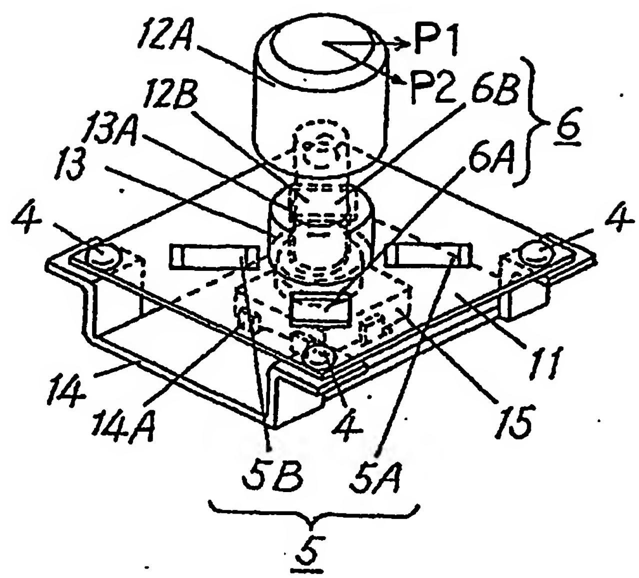
12A
P1
P2
6B
6
12B
13A
6A
13
4
4
11
14
15
14A
4
5B
5A
5

Fig. 3

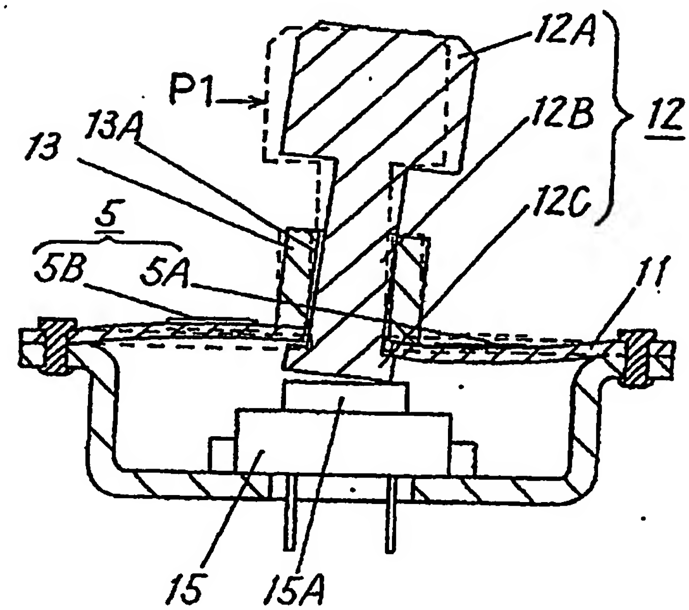
12A
P1
13A
12B
12
13
12C
5
5B
5A
11
15
15A

Fig. 4

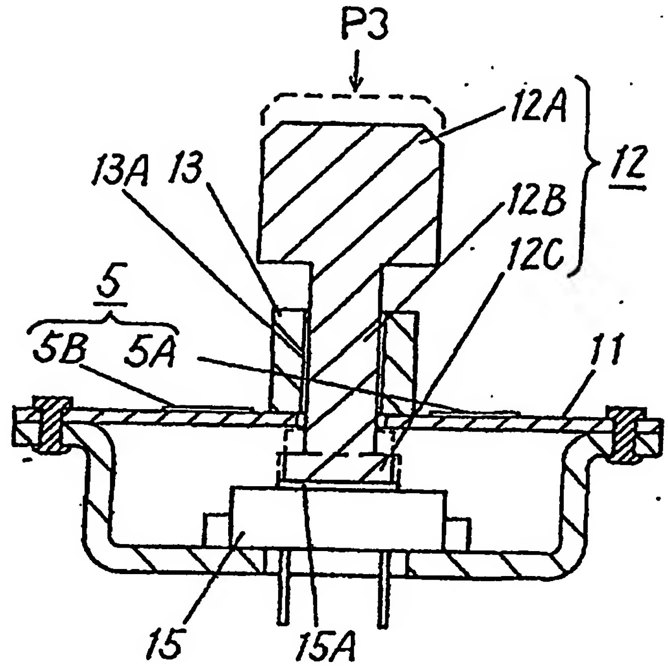

Fig. 5

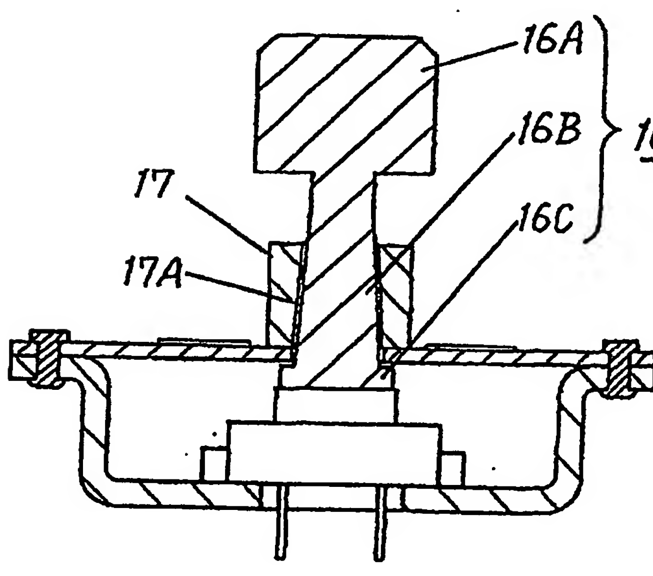

Fig. 6

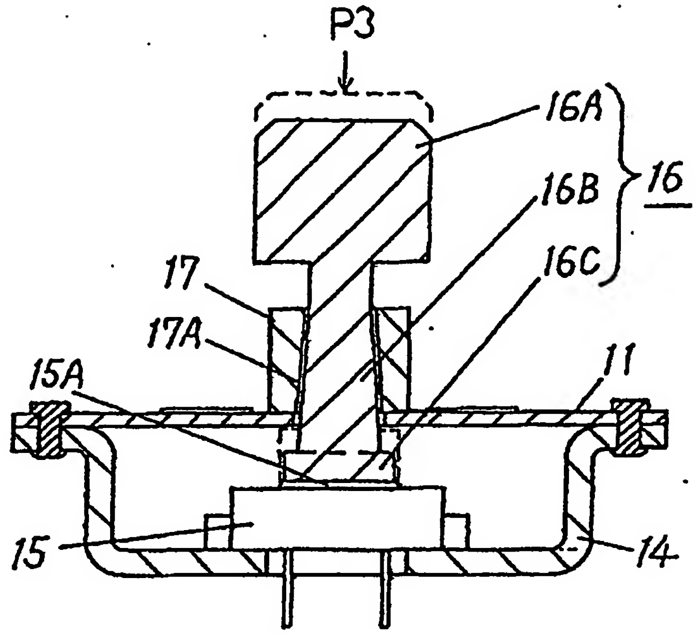
P3
16A
16B
16
16C
17
17A
11
15A
15
14

Fig. 7

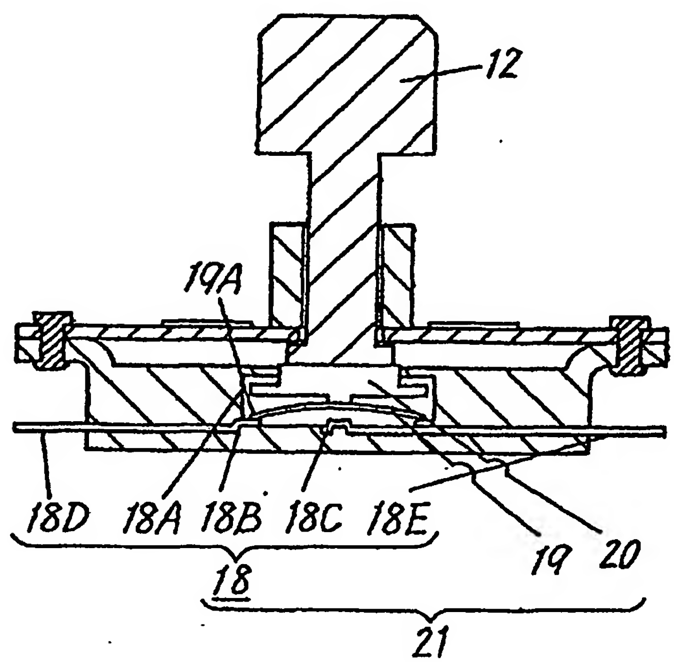
12
19A
18D
18A
18B
18C
18E
19
20
18
21

Fig. 8

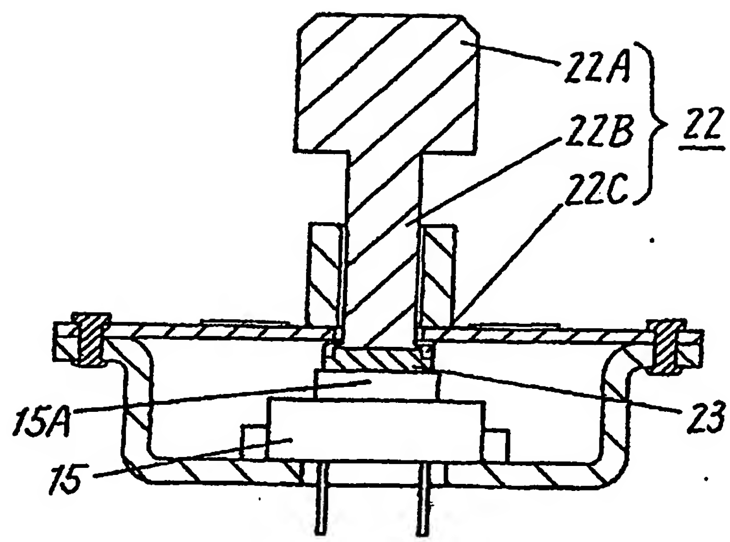

Fig. 9

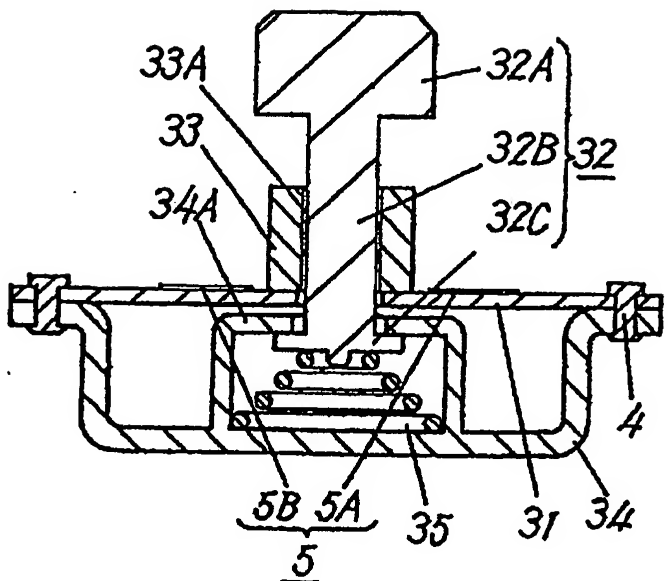

Fig. 10

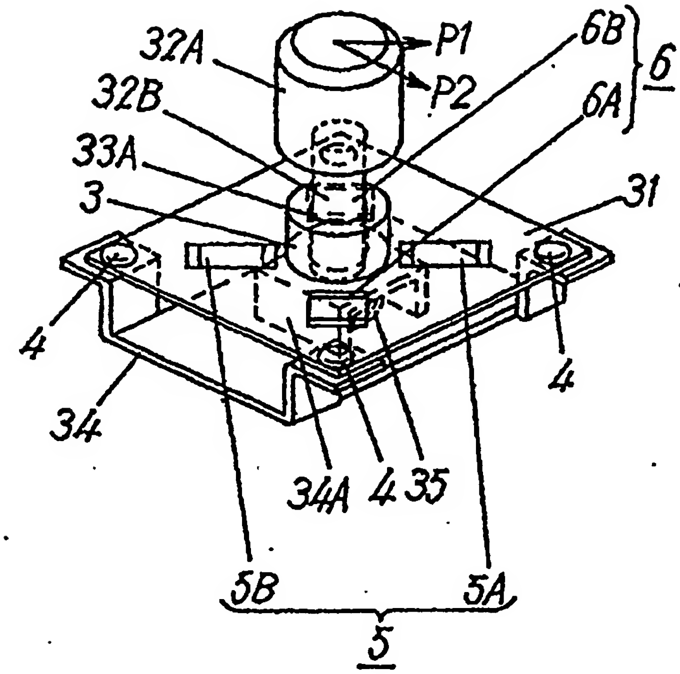
32A
P1
P2
6B
6
6A
32B
33A
3
31
4
4
34
34A
4
35
5B
5A
5

Fig. 11

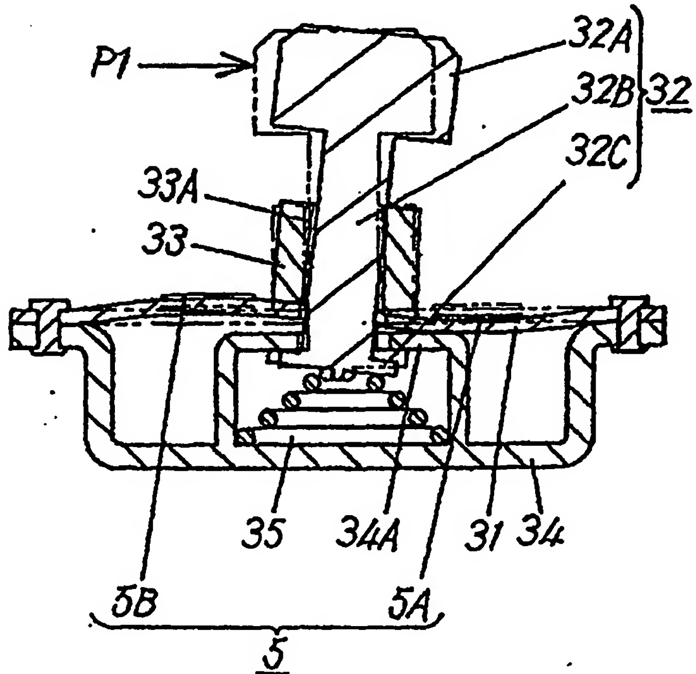
P1
32A
32B
32
32C
33A
33
35
34A
31
34
5B
5A
5

Fig. 12

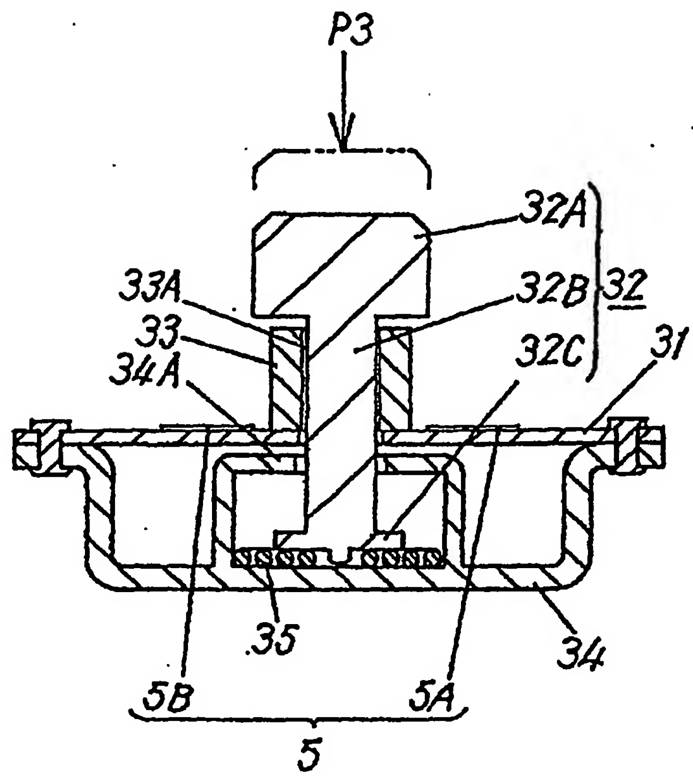

Fig. 13 (a)

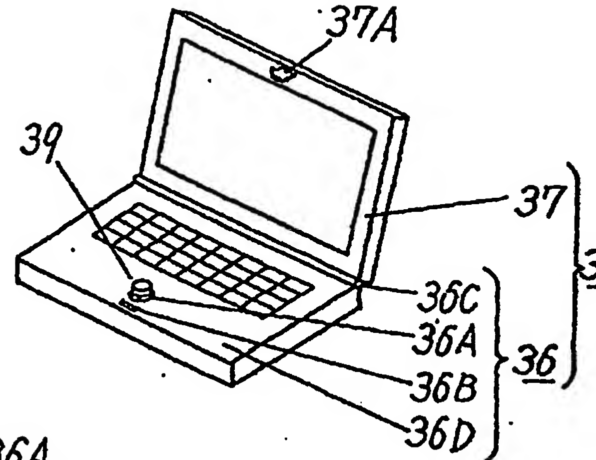

Fig. 13 (b)

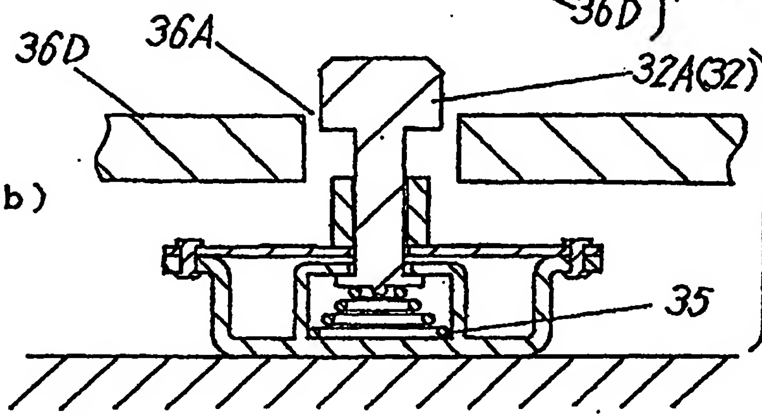

Fig. 13 (c)

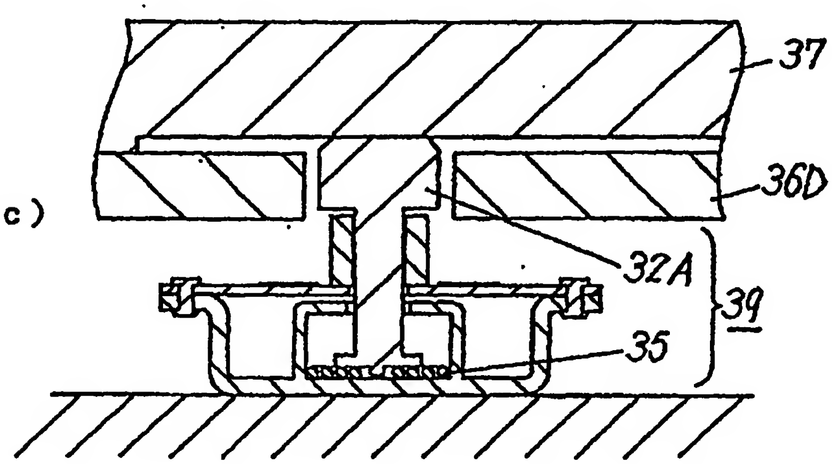

Fig. 14

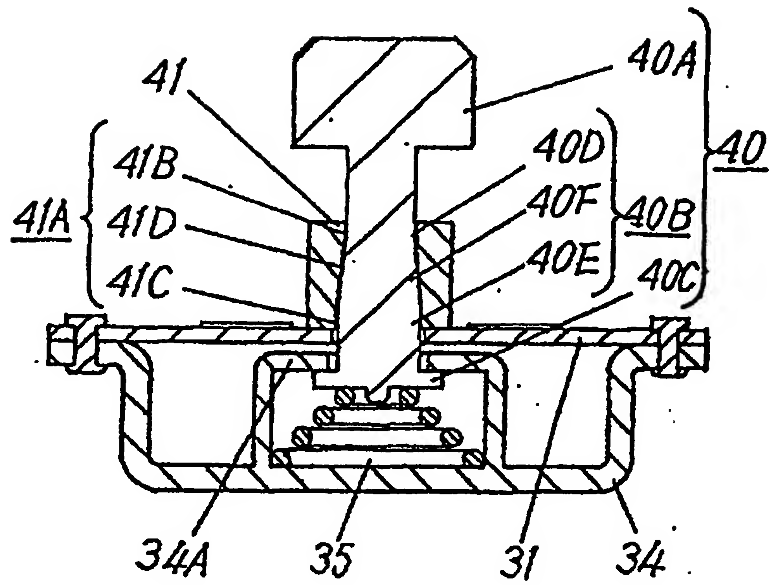
41
40A
41B
40D
40
41A
41D
40F
40B
41C
40E
40C
34A
35
31
34

Fig. 15

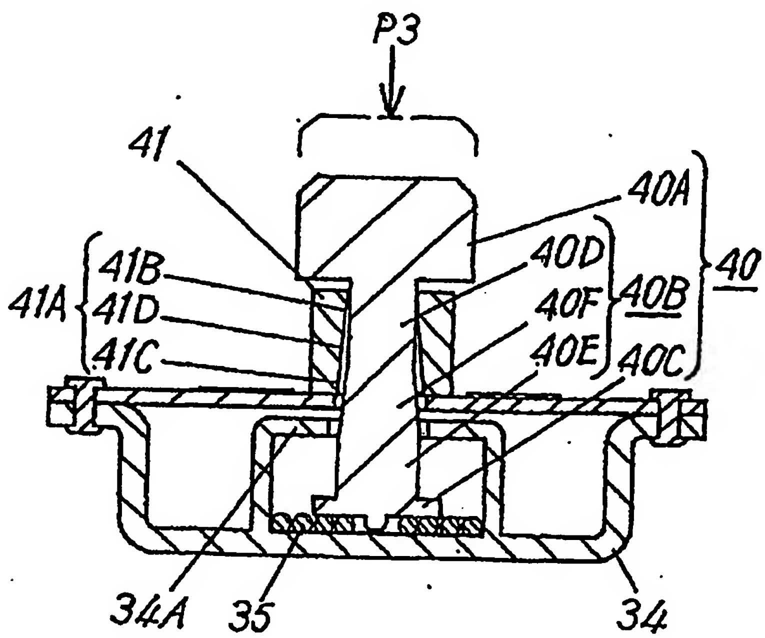
P3
41
40A
41B
40D
40
41A
41D
40F
40B
41C
40E
40C
34A
35
34

Fig. 16

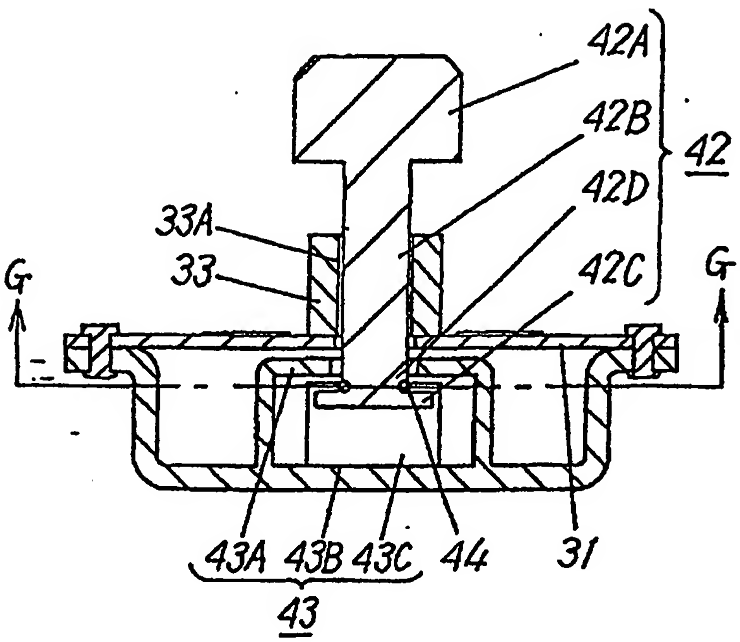

Fig. 17

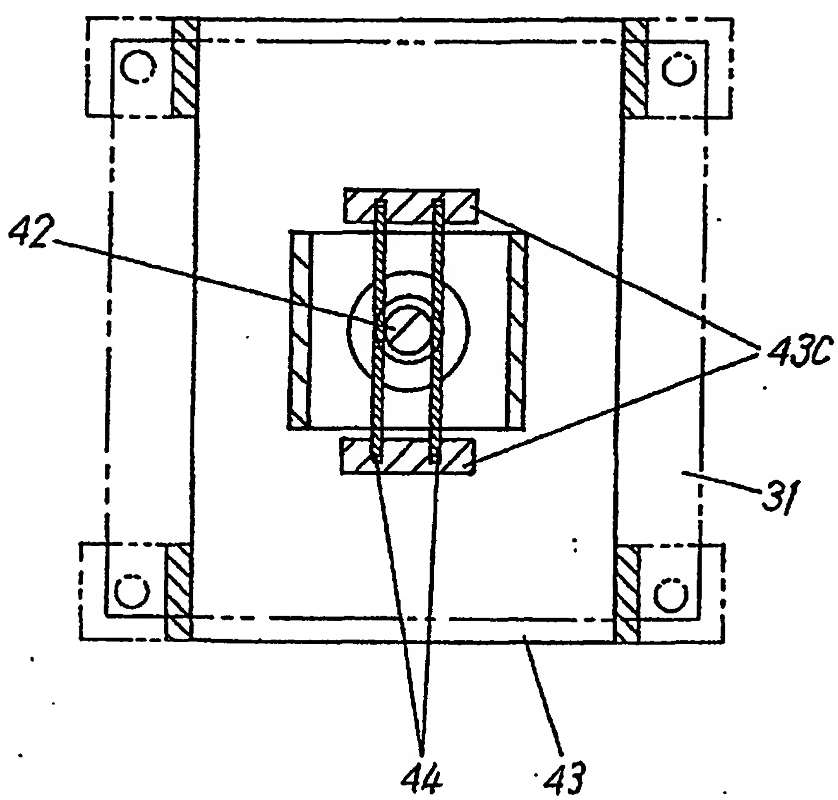

Fig. 18

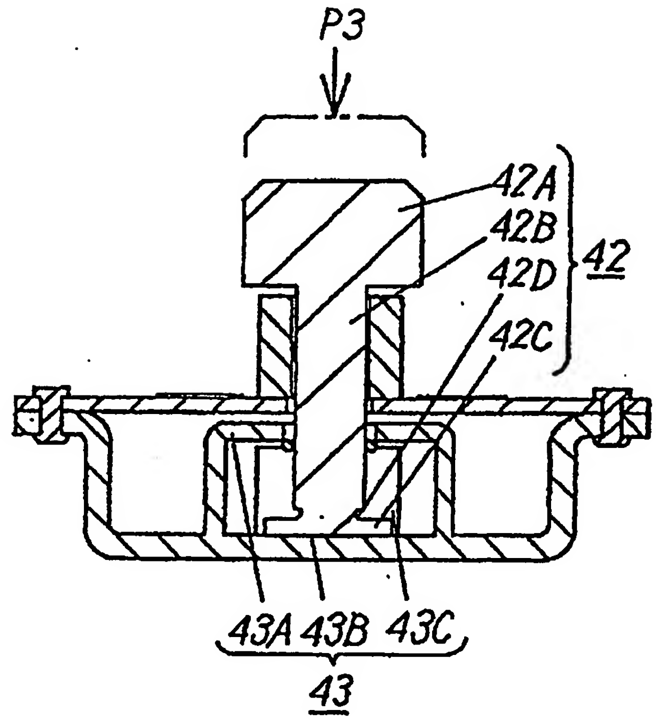
P3
42A
42B
42D
42C
42
43A
43B
43C
43

Fig. 19

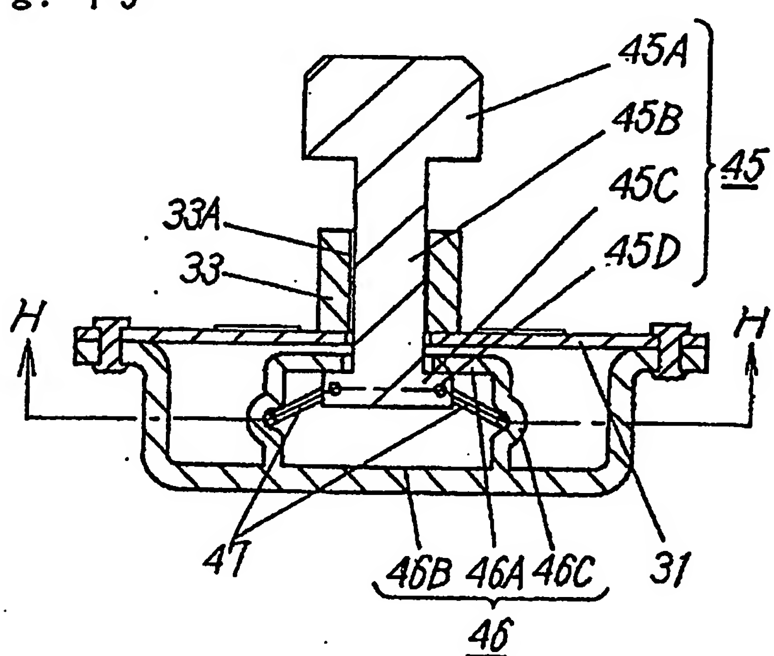
45A
45B
45C
45D
45
33A
33
H
H
47
46B
46A
46C
31
46

Fig. 20

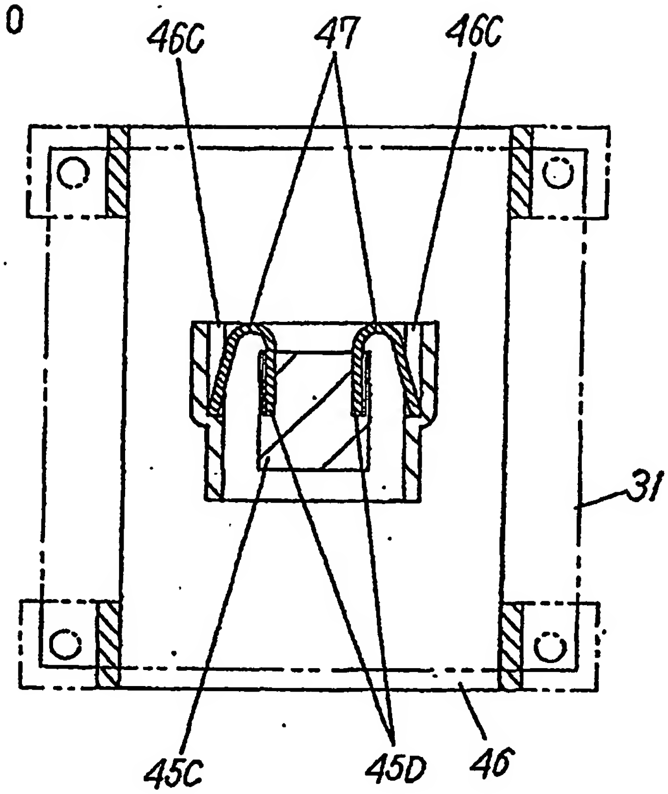

Fig. 21

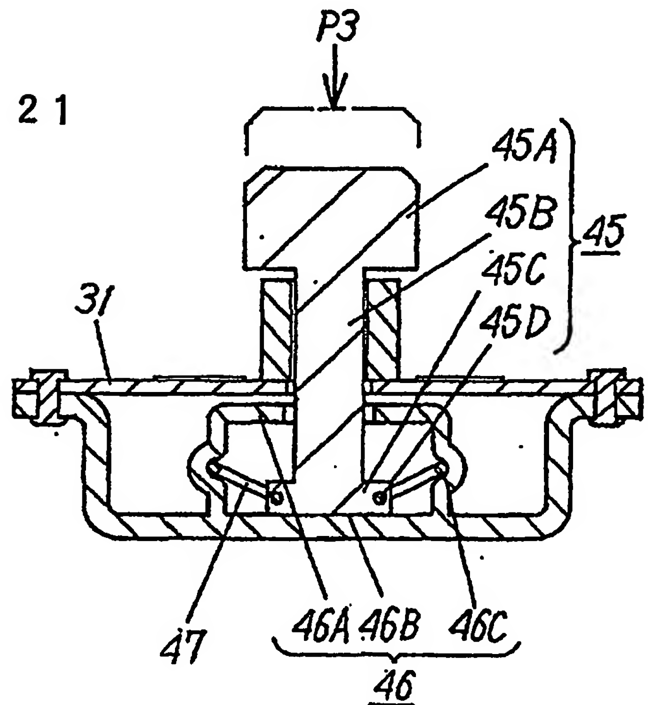

Fig. 22

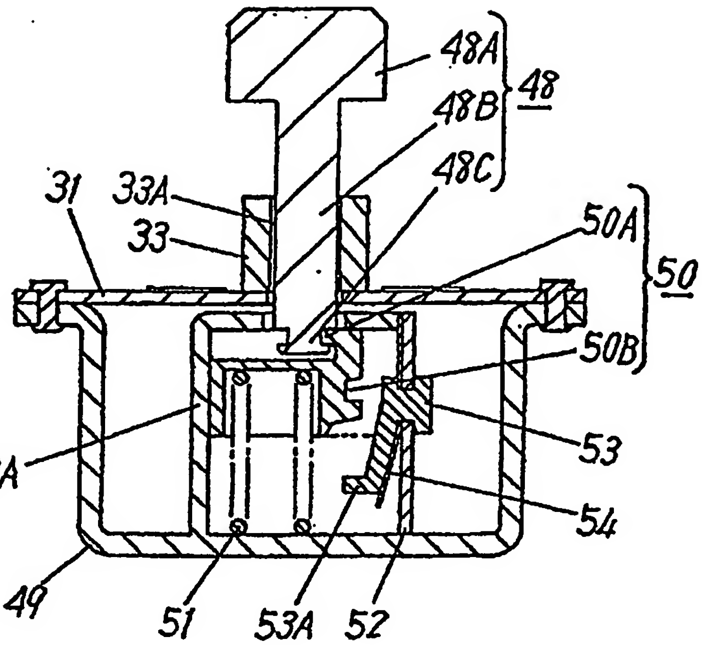
48A
48
48B
48C
31
33A
33
50A
50
50B
53
49A
54
49
51
53A
52

Fig. 23

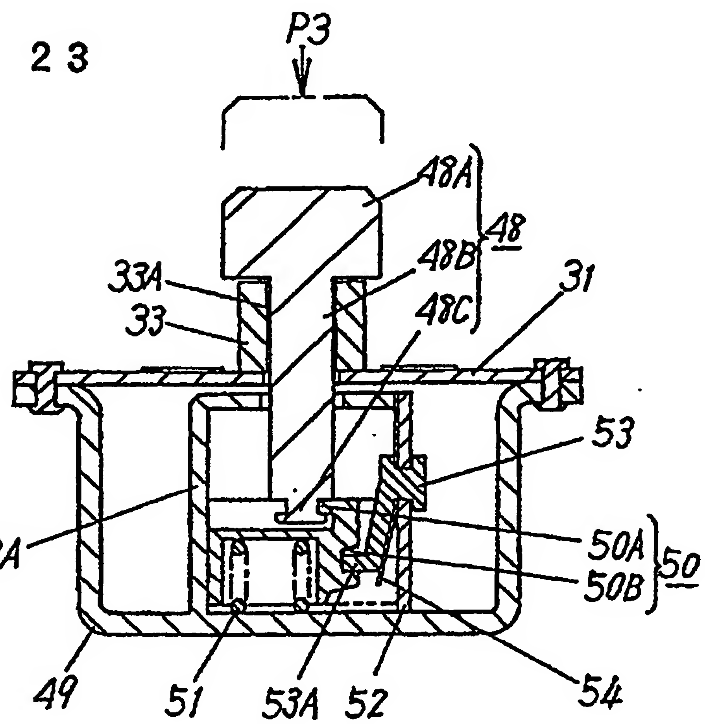
P3
48A
48
48B
33A
31
33
48C
53
49A
50A
50
50B
49
51
53A
52
54

Fig. 24

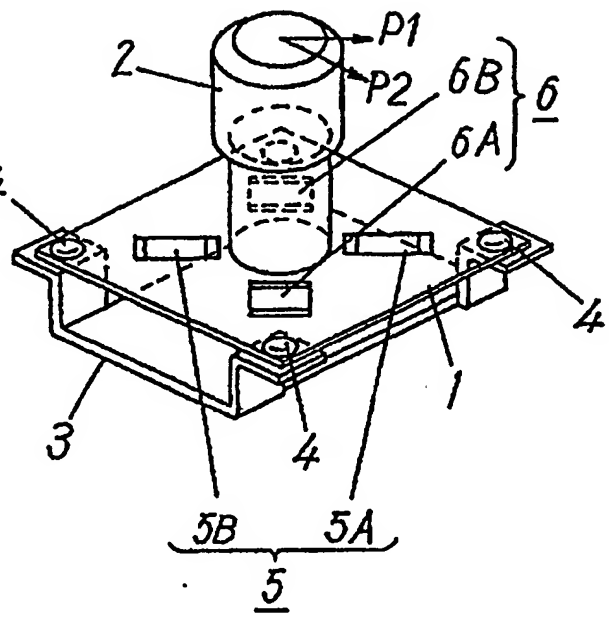

Fig. 25